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Two New Species of *Lampeia* (Bivalvia: Thraciidae) from the Northwestern Pacific, with Notes on *Lampeia adamsi* (MacGinitie, 1959)

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Abstract. The genus *Lampeia* was previously represented in the Chukchi Sea and the northwestern Bering Sea by only one species, *Lampeia adamsi* (MacGinitie, 1959). We found *L. adamsi* in the Sea of Okhotsk at depths of 65–85 m. Additionally, we described two new species from this genus. *Lampeia* ***triangula*** was found in the Sea of Okhotsk off the west coast of Kamchatka at a depth of 144–214 m, *Lampeia* ***posteroresecta*** off the Kurile Islands near Iturup Island at 180 m and in the Fourth Kurile Strait at 500 m. An expanded description of *L. adamsi,* including some additional data on shell morphology, geographic distribution, and habitat is also given.

INTRODUCTION

The genus *Lampeia* (MacGinitie, 1959) was originally described as a new subgenus of the genus *Thracia* Blainville, 1824 (MacGinitie, 1959). Later, this subgenus was elevated by Baxter (1987) to the generic level, still represented only by *Lampeia adamsi* (MacGinitie, 1959) found about 2.5 miles off Point Barrow, Arctic coast of Alaska (MacGinitie, 1959).

For a long time, *L. adamsi* was known only from the Arctic seas. Bernard (1983) did not list it in his catalogue of the living Bivalvia of the eastern Pacific Ocean, in which he listed the species of bivalve mollusks from the Bering Strait (66°N) to Cape Horn (60°S). Baxter (1987) mentioned it only among the fauna of the Chukchi and Beaufort seas. In a detailed review of the contemporary eastern Pacific species of the Thraciidae, Coan (1990) gave the distribution of *L. adamsi* from off Point Barrow westward into the northwestern Bering Sea off Mys Chaplino, Chukotskiy Poluostrov.

No representatives of the genus *Lampeia* have been found previously in the far-eastern and Arctic seas of Russia (Gorbunov, 1952; Golikov & Scarlato, 1977; Scarlato, 1981). As a result of analysis of numerous data on bivalve mollusks collected by many expeditions to the shelf of the western Bering Sea, the Commander Islands, southeastern Kamchatka, the Sea of Okhotsk, and the shelf and bathyal zones of the Kurile Islands, we found material of *Lampeia.* A comparison of our specimens with *L. adamsi* (young and adult specimens) from the northwestern Bering Sea and with the descriptions and photographs of the type specimen (MacGinitie, 1959; Coan, 1990) showed that we found three species. One of the species is *L. adamsi.* This species was found in Russian far-eastern seas for the first time. Two species from our material are new to science. Also, some additional studies of *L. adamsi* from the northwestern part of the Bering Sea were conducted. The purpose of this paper is to describe two new species of the genus *Lampeia* and to give an expanded description of *L. adamsi,* supplemented by new data on its shell morphology, geographic distribution, and habitat.

MATERIALS AND METHODS

In this study the materials on the bivalve mollusks were collected by PRIFO (Pacific Research Institute of Fisheries and Oceanography) expeditions to the Sakhalinsky Bay of the Sea of Okhotsk (R/V *8-452,* 1977) (Figure 1) and to the coastal zone of the western Kamchatka (R/V *Mys Dalny,* 1989 and R/V *Professor Levanidov,* 1996), and a joint Institute of Marine Biology (IMB) PRIFO expedition to the shelf and bathyal zones of the Kurile Islands (R/V *Tikhookeansky,* 1987).

The material from the western Kamchatka was fixed and stored in 4% formaldehyde in the PRIFO. All the other material was stored dry in the IMB.

To separate the material of *Lampeia* into taxa, we used the following characters: proportions and shell shape, lithodesma shape, and peculiarities of shell inner structure. The material of *Lampeia* consisted of both young and adult specimens. A thorough examination revealed distinguishing characters with slight age variability. These diagnostic characters are fairly reliable and allowed us to consider differences in shell morphology among *Lampeia* to be differences on the species level.

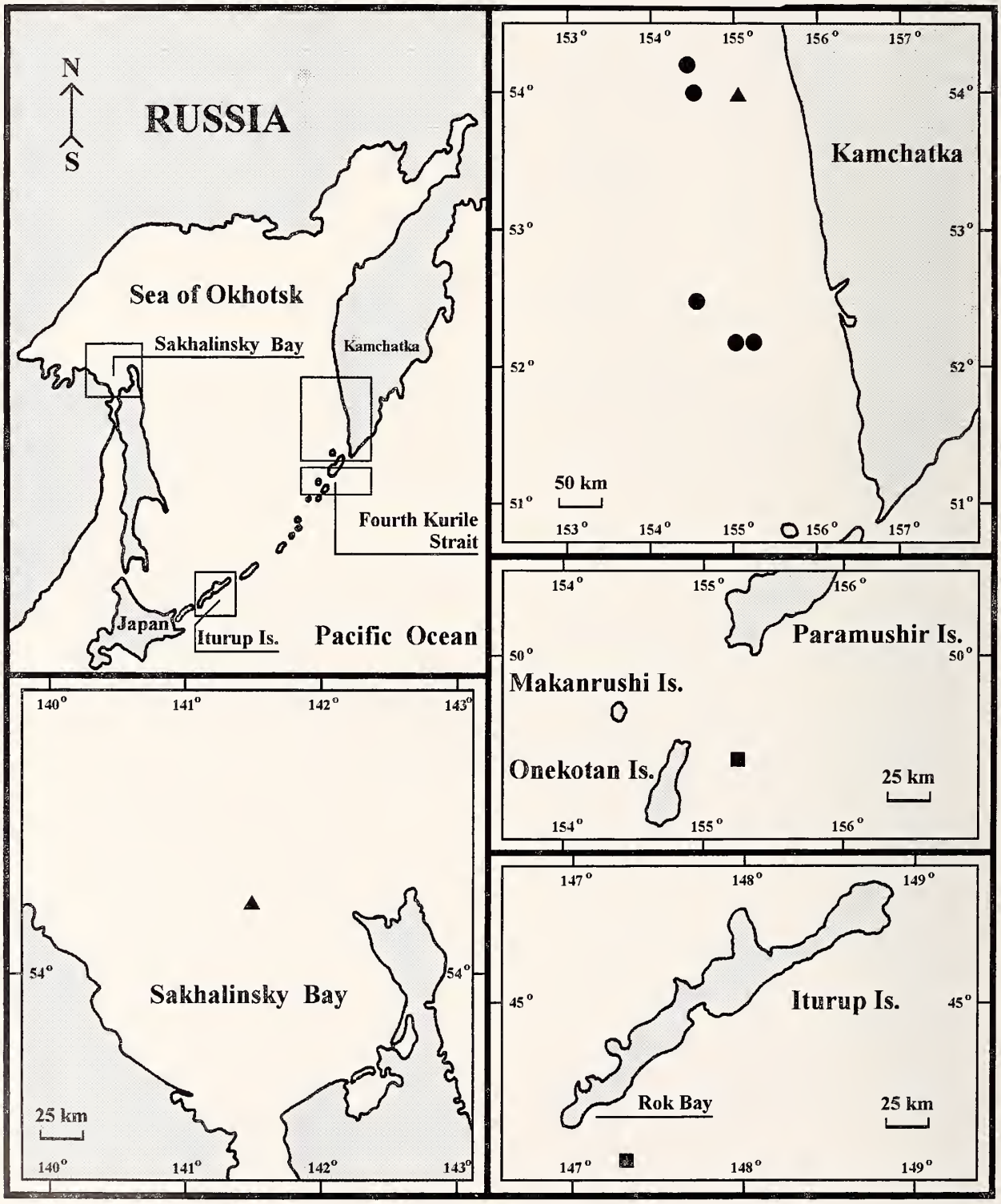

Figure 1

Map showing distributions of *Lampeia* ***triangula*** Kamenev & Nadtochy, sp. nov. (●), *Lampeia* ***posteroresecta*** Kamenev, sp. nov. (■) and *Lampeia adamsi* (MacGinitie, 1959) (▲).

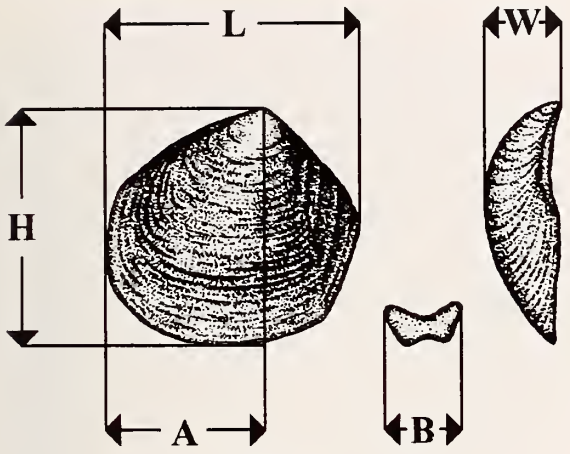

Figure 2

Placement of shell and lithodesma measurements: L—shell length; A—length of anterior end shell; H—height; W—valve width; B—lithodesma length.

Figure 2 shows the position of our shell morphology measurements. Shell length (L), anterior end length (A), height (H), width of each valve (W), length of lithodesma (B) of all the specimens were measured and the ratio of these parameters to shell length (A/L, H/L, W/L, and B/L, correspondingly) were determined. The number of pillars supporting the subumbonal structure for lithodesma in each valve was also recorded. Shell measurements were made using a calipers and an ocular micrometer with an accuracy of 0.1 mm.

The following abbreviations are used: IMB, Institute of Marine Biology, Russian Academy of Sciences, Vladivostok; MIMB, Museum of the Institute of Marine Biology, Vladivostok; PRIFO, Pacific Research Institute of Fisheries and Oceanography, Vladivostok; UAM, University of Alaska Museum, Fairbanks; USNM, United States National Museum of Natural History, Smithsonian Institution, Washington, D.C.

SYSTEMATICS

Family Thraciidae Stoliczka, 1870

Lampeia MacGinitie, 1959

Type species (by original designation): *Thracia (Lampeia) adamsi* MacGinitie, 1959; Point Barrow, Arctic coast of Alaska.

Diagnosis: Shell small, inequivalve, truncate posteriorly, covered with a thick brown periostracum. Right valve larger, more inflated. Anterior end longer than posterior. Lunule and escutcheon conspicuous. Ligament both external and internal; external ligament indistinct, represented by a narrow band on dorsal shell margin; main ligament internal, attached to elongate-trigonal structure on shell wall under beaks, extending obliquely posterior from beaks, free along its anteroventral margin, where it is supported by a series of pillars separated by shallow pits. Internal ligament supported by a strong lithodesma. The right valve of some species with a more or less conspicuous toothlike process anterior to the beak on the inner part of anterodorsal margin resembling a true lateral tooth. Pallial line with U-shaped pallial sinus not reaching the midline. Pallial sinus not confluent with pallial line.

Remarks: Coan (1990) showed that the representatives of the genus *Lampeia* have a simple curved lithodesma. An analysis of material of other species shows that the lithodesma shape in representatives of this genus varies greatly and often resembles a butterfly with open wings. One side of it is very curved, corresponding to the form and location of the elongate-trigonal structure on the shell wall, and the opposite side is slightly concave to match the toothlike process on the anterodorsal shell margin, and it partly fits into this depression.

As Coan (1990) noticed, the hinge of this genus is closest to that of *Asthenothaerus* Carpenter, 1864. However, *Asthenothaerus* has no subumbonal structure on the shell wall, supported by pillars. Instead, under the beak, *Asthenothaerus* has a platform for attachment of the ligament and lithodesma. This platform is directed posteriorly, slightly elevated above the inner shell surface and tightly attached to the shell wall. The lithodesma of *Asthenothaerus* is also butterfly-shaped, but it is less massive, more angular, with long, sharp ends, and, in general, has a more complex shape. Species of *Asthenothaerus* also lack an external ligament and have a very thin shell without a thick brown periostracum. They have a thin, tan periostracum.

The hinge of *Lampeia* is also similar to that of *Trigonothracia* Yamamoto, Habe, 1959, which has a small chondrophore and crescentlike lithodesma (Yamamoto & Habe, 1959; Xu, 1980). However, the chondrophore of this genus is directed anteriorly and is not supported by pillars, and the shell is thin and fragile, with a light yellow or brownish periostracum.

We recognized more than one taxon within *Lampeia*. Table 1 describer the main differentiating characters of the three species of *Lampeia*.

Lampeia ***triangula*** Kamenev & Nadtochy, sp. nov.

(Figures 3–23, Table 2)

Diagnosis: Shell high, ovately triangular, twisted posteriorly; beaks high, central or slightly posterior to midline, somewhat sharp, not opisthogyrate; anterior end angular-rounded; posterior end decidedly truncate; anterodorsal and posterodorsal margins straight (sometimes slightly convex), very steeply extending ventrally; posterior margin anteriorly directed; right valve anterior to

Table 1

Some taxonomic characters of the species of *Lampeia*.

Characters	*Lampeia* ***triangula*** Kamenev & Nadtochy, sp. nov.	*Lampeia* ***posteroresecta*** Kamenev, sp. nov.	*Lampeia adamsi* (MacGinitie, 1959)
Shell shape	ovately triangular, twisted posteriorly	ovately quadrangular	ovately subquadrate
Anterior shell end	angular-rounded	rounded	obtusely rounded
Posterior shell end	decidedly truncate	decidedly truncate	broadly subtruncate
Posterodorsal shell margin	straight	concave	straight
Posterior shell margin	anteriorly directed	vertically extending ventrally	anteriorly directed
Beaks	somewhat sharp, not opisthogyrate	slightly rounded, opisthogyrate	rounded, opisthogyrate
Toothlike process on right valve	present	present	absent
Pillars of subumbonal structure	long, wide	long, thin	short, thin
Large pit between anterodorsal shell margin and pillars	absent	absent	present
Lithodesma shape	butterfly-shaped	butterfly-shaped	simple, curved

beak with weakly expressed toothlike process on inner part of anterodorsal margin; pillars supporting subumbonal structure for lithodesma long and wide; lithodesma butterfly-shaped.

Description: *Exterior.* Shell small (to 16.2 mm), high (height almost equal to length), ovately triangular, twisted posteriorly, thick, strong, white under periostracum, slightly inequivalve; right valve slightly higher, sometimes slightly longer, slightly more inflated; periostracum fairly thick, adherent, brown, extending into inner shell surface; surface with conspicuous growth lines, without pustules; beaks central or slightly posterior to mid-line, high, somewhat sharp, not opisthogyrate; anterior end angular-rounded; posterior end decidedly truncate with a faint radial ridge extending from posterior portion of beaks to transition of posterior shell margin to ventral margin; anterodorsal margin straight (sometimes slightly convex), very steeply extending ventrally, forming a very smooth angle at transition to anterior margin; anterior margin slightly curved, rather smoothly transitioning to ventral margin; ventral margin slightly curved; posterodorsal margin straight, very steeply extending ventrally, abruptly transitioning to posterior margin, forming a distinct angle; posterior margin straight, anteriorly directed, forming a smooth angle at transition to ventral margin; lunule present only in left valve, wide, deep, well expressed along entire anterodorsal margin, demarcated by a ridge extending along anterodorsal margin from beaks to anterior margin; escutcheon wide, deep, more expressed in left valve, demarcated by ridges, extending along posterodorsal margin from beaks to dorsal margin.

Interior. Right valve anterior to beak with a small, weakly expressed toothlike process on inner part of anterodorsal margin, often covered with periostracum; in

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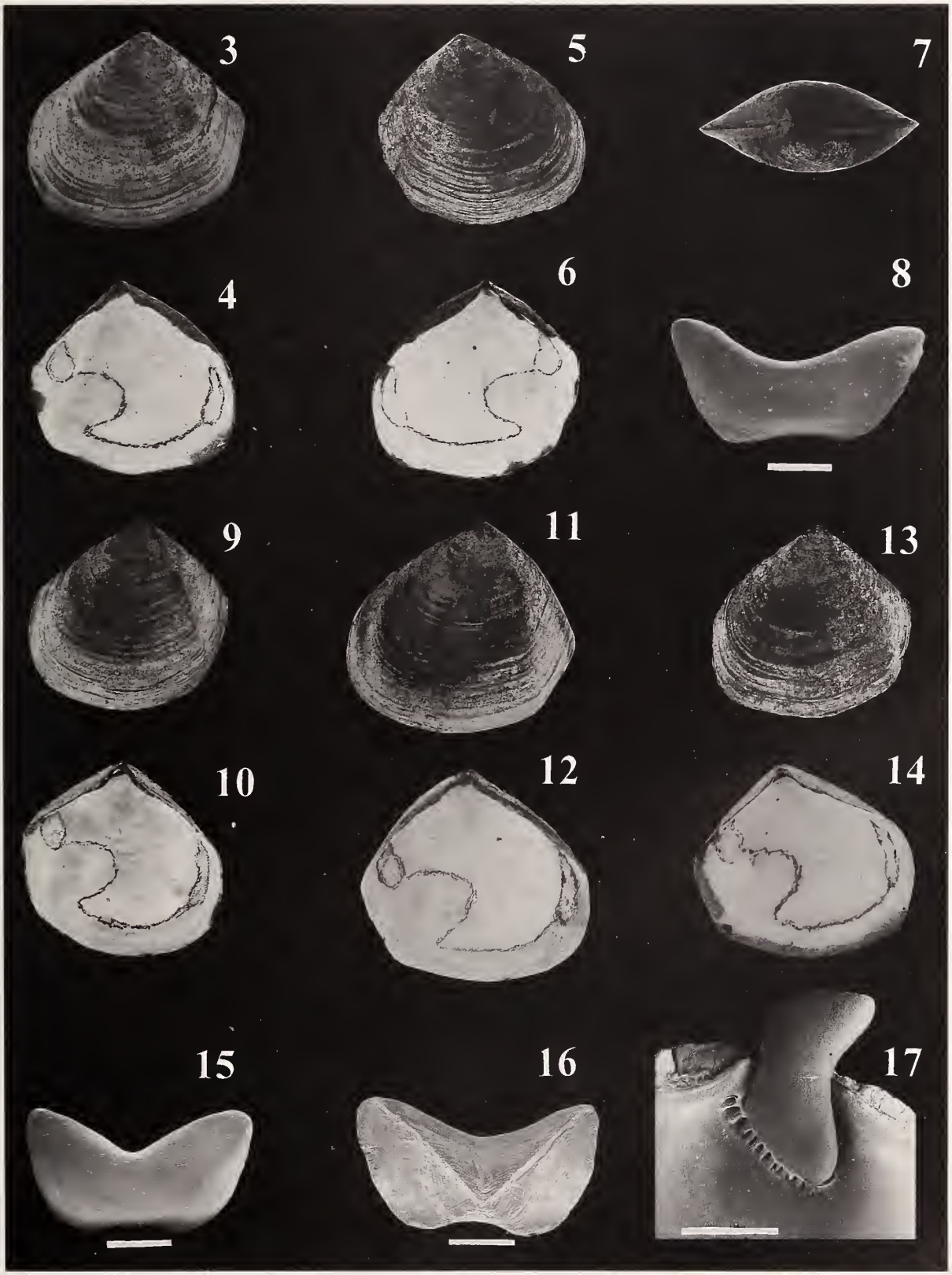
Explanation of Figures 3–17

Lampeia triangula Kamenev & Nadtochy, sp. nov. Figures 3–8. Holotype (MIMB 1/35169), west coast of Kamchatka, Sea of Okhotsk (52°44′9″, 154°54′5″E), 192 m depth. Figures 3, 4. Left valve, length 16.2 mm. Figures 5, 6. Right valve, length 16.2 mm. Figure 7. Dorsal view of both valves. Figure 8. Ventral view of lithodesma. Scale = 1 mm. Figures 9, 10. Paratype (MIMB 5/35173), west coast of Kamchatka, Sea of Okhotsk (54°20′N, 154°18′E), 144 m depth, left valve, length 15.6 mm. Figures 11, 12. Paratype (MIMB 4/35172), west coast of Kamchatka, Sea of Okhotsk (52°44′9″N, 154°54′5″E), 192 m depth, left valve, length 16.1 mm. Figures 13, 14. Paratype (MIMB 6/35174), west coast of Kamchatka, Sea of Okhotsk (54°20′N, 154°03′6″E), 204 m depth, left valve of a young specimen, length 11.5 mm. Figure 15. Paratype (MIMB 4/35172), west coast of Kamchatka, Sea of Okhotsk (52°44′9″N, 154°54′5″E), 192 m depth. Ventral view of lithodesma. Scale = 1 mm. Figure 16. Paratype (MIMB 5/35173), west coast of Kamchatka, Sea of Okhotsk (54°20′N, 154°18′E), 144 m depth. Dorsal view of lithodesma. Scale = 1 mm. Figure 17. Paratype (MIMB 4/35172), west coast of Kamchatka, Sea of Okhotsk (54°44′9″N, 154°54′5″E), 214 m depth. Close-up of right valve showing the attachment of lithodesma (ventral view) to the buttressed subumbonal structure and the toothlike process on the anterodorsal margin anterior to the beak. Scale = 1 mm.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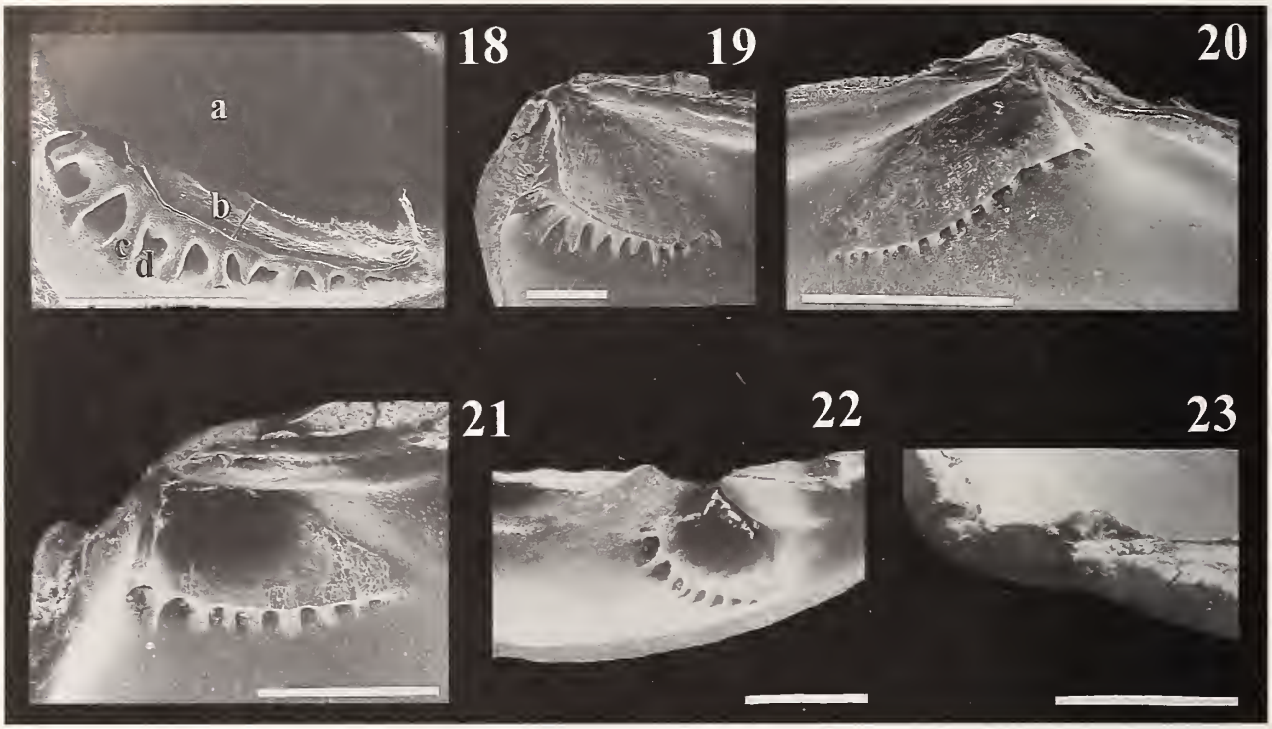

Explanation of Figures 18–23

Lampeia ***triangula*** Kamenev & Nadtochy, sp. nov. Figure 18. Fragment of right valve showing the ligament and pillars of the buttressed subumbonal structure. (a) Lithodesma. (b) Ligament. (c) Pillar. (d) Pit. Scale = 1 mm. Figure 19. Fragment of a right valve showing the buttressed subumbonal structure without ligament. Scale = 1 mm. Figure 20. Paratype (MIMB 4/35172), west coast of Kamchatka, Sea of Okhotsk (54°44′9″N, 154°54′5″E), 214 m depth. Close-up of a left valve showing the buttressed subumbonal structure without ligament and the inner part of the dorsal margin near beak. Scale = 1 mm. Figures 21–23. Paratype (MIMB 6/35174), western coast of Kamchatka, Sea of Okhotsk (54°20′N, 154°03′6″E), 204 m depth. Close-up of a right valve showing the buttressed subumbonal structure without ligament and the toothlike process on the anterodorsal margin. Scale = 1 mm. Figure 21. Interior view. Figure 22. Ventral view. Figure 23. Dorsal view of toothlike process.

left valve anterior to beak; inner part of posterodorsal margin slightly concave; elongate-trigonal subumbonal structure for lithodesma attached to shell wall short; pillars supporting this structure long, in general of the same thickness throughout their length; width of pits between pillars decreasing posteriorly from anterodorsal margin—at anterodorsal margin their width is larger than that of pillars and at posterior they are much smaller; number of pillars varies from eight to 15, lithodesma butterfly-shaped; anterior adductor muscle scar large, elongate; posterior adductor scar large, rounded; pallial sinus medium-sized, broad, of the same shape in both valves, reaching almost to middle of shell, stopping just short of midline; ventral edge of pallial sinus not confluent with pallial line.

Variability: In adult specimens, shell shape and proportions are substantially constant. The shell height-length ratio slightly varies (in the largest specimens height is almost equal to length) (Table 2). Beak sometimes occupies the central position. Anterodorsal and posterodorsal margins are sometimes slightly convex. In young specimens, as compared to adult specimens, shell more elongate, less convex; angles at transition of dorsal margin into anterior and posterior margins and also at their transition into ventral margin are sharper, as a result of which the shell is more angular; beaks sharper, less posteriorly placed, more often central; anterodorsal and posterodorsal margins always straight; length of lithodesma smaller compared to shell length. The relative length of lithodesma increases with age. The shape of lithodesma can vary considerably, but it is always butterfly-shaped. The number of pillars supporting the elongate-trigonal structure varies and is not strongly correlated with shell size.

Type material and locality: Holotype (MIMB 1/35169), west coast of Kamchatka, Sea of Okhotsk (52°44′9″N, 154°54′5″E) (Figure 1), 192 m depth, sandy silt, bottom temperature +0.95°C, Coll. V.A. Nadtochy, 25 July 1989 (R/V *Mys Dalny*). Paratypes (10): Paratypes (3) (MIMB 2/35170), west coast of Kamchatka, Sea of Okhotsk

Table 2

Lampeia ***triangula*** Kamenev & Nadtochy, sp. nov. Shell parameters of the holotype (in italics) and paratypes: L—shell length; A—anterior end length; H—height; W—width; B—lithodesma length; H/L—height–length ratio; A/L—anterior end length–length ratio; W/L—width–length ratio; B/L—lithodesma length–length ratio; N—number of pillars in the buttressed subumbonal structure. Measurements in mm.

Valve	L	A	H	W	B	H/L	A/L	W/L	B/L	N	Depository
Right	9.5	4.7	8.4	1.9	1.6	0.88	0.50	0.20	0.17	13	MIMB
Left	9.5	4.7	8.2	1.7	—	0.86	0.50	0.18	0.17	13	3/35171
Right	10.2	5.3	8.8	2.0	1.6	0.86	0.52	0.20	0.16	10	MIMB
Left	10.1	5.1	8.7	1.9	—	0.86	0.51	0.19	0.16	10	6/35174
Right	10.4	5.5	9.4	2.2	1.7	0.90	0.53	0.21	0.16	13	MIMB
Left	10.4	5.5	9.4	2.1	—	0.90	0.53	0.20	0.16	13	4/35172
Right	10.7	5.8	9.2	2.2	1.7	0.86	0.54	0.21	0.16	14	MIMB
Left	10.7	5.8	9.0	2.1	—	0.84	0.54	0.20	0.16	14	6/35174
Right	11.6	6.0	10.4	2.4	2.0	0.90	0.52	0.21	0.17	8	MIMB
Left	11.5	5.9	10.4	2.3	—	0.90	0.51	0.20	0.17	8	6/35174
Right	12.7	6.5	11.6	2.7	2.5	0.91	0.51	0.21	0.20	10	MIMB
Left	12.6	6.5	11.6	2.6	—	0.92	0.52	0.21	0.21	10	2/35170
Right	14.0	7.0	13.0	3.4	2.8	0.93	0.50	0.24	0.20	13	MIMB
Left	14.0	7.0	13.0	3.2	—	0.93	0.50	0.23	0.20	13	2/35170
Right	14.7	8.5	13.2	3.3	2.8	0.90	0.51	0.22	0.20	15	MIMB
Left	14.7	8.5	13.1	3.0	—	0.89	0.51	0.22	0.20	15	2/35170
Right	15.0	8.3	13.8	3.7	3.3	0.92	0.55	0.25	0.22	11	MIMB
Left	15.0	8.3	13.7	3.4	—	0.91	0.55	0.23	0.22	11	4/35172
Right	15.7	8.6	14.9	3.8	3.6	0.95	0.55	0.24	0.23	12	MIMB
Left	15.6	8.3	14.7	3.4	—	0.94	0.53	0.22	0.23	12	5/35173
Right	*16.2*	*9.0*	*15.2*	*3.7*	*3.4*	*0.94*	*0.56*	*0.23*	*0.21*	*15*	MIMB
Left	*16.2*	*9.0*	*15.1*	*3.3*	—	*0.93*	*0.56*	*0.20*	*0.21*	*15*	1/35169

(54°20′N, 154°30′8″E), 160 m depth, silt sand, Coll. V.A. Nadtochy, 28 July 1989 (R/V *Mys Dalny*); Paratype (MIMB 3/35171), west coast of Kamchatka, Sea of Okhotsk (54°N, 154°33′6″E), 161 m depth, sandy silt, Coll. V.A. Nadtochy, 26 July 1989 (R/V *Mys Dalny*); Paratypes (2) (MIMB 4/35172), west coast of Kamchatka, Sea of Okhotsk (54°44′9″N, 154°54′5″E), 192 and 214 m depth, sandy silt, Coll. V.A. Nadtochy, 25 July 1989 (R/V *Mys Dalny*); Paratype (MIMB 5/35173), west coast of Kamchatka, Sea of Okhotsk (54°20′N, 154°18′E), 144 m depth, sandy silt, Coll. V.A. Nadtochy, 25 July 1989 (R/V *Mys Dalny*); Paratypes (3) (MIMB 6/35174), west coast of Kamchatka, Sea of Okhotsk (54°20′N, 154°03′6″E), 204 m depth, silt sand, Coll. V.A. Nadtochy, 25 July 1989 (R/V *Mys Dalny*).

Other material examined: Five slightly damaged specimens and 1 specimen without detailed label from the type locality.

Distribution and habitat (Figure 1): Known only from type locality.

Comparison: *Lampeia* ***triangula*** differs distinctly from *L. adamsi* in having a ovately triangular shell, a butterfly-shaped lithodesma, and a toothlike process on the anterodorsal margin of the right valve. Externally, *L.* ***triangula*** (especially young specimens) is most similar to *L.* ***posteroresecta,*** but has higher beaks that are not opisthogyrate, more steeply sloping anterodorsal and posterodorsal shell margins, a smaller apical angle, anteriorly directed posterior shell margin, more triangular shell shape, wider pillars supporting subumbonal structure for lithodesma and less evident toothlike process on the anterodorsal shell margin.

Etymology: triangular (Latin).

Lampeia ***posteroresecta*** Kamenev, sp. nov.

(Figures 24–38, Table 3)

Diagnosis: Shell high, ovately quadrangular; beaks slightly posterior to mid-line, somewhat rounded, opistogyrate; anterior end rounded; posterior end decidedly truncate; anterodorsal margin slightly convex; posterodorsal margin slightly concave; posterior margin vertically extending ventrally; right valve anterior to beak with a conspicuous toothlike process on inner part of anterodorsal margin; pillars supporting subumbonal structure for lithodesma long and thin; lithodesma butterfly-shaped.

Description: *Exterior.* Shell small (to 20.3 mm), high,

Table 3

Lampeia posteroresecta Kamenev, sp. nov. Shell parameters of the holotype (in italics) and paratypes: L—shell length; A—anterior end length; H—height; W—width; B—lithodesma length; H/L—height–length ratio; A/L—anterior end length–length ratio; W/L—width–length ratio; B/L—lithodesma length–length ratio; N—number of pillars in the buttressed subumbonal structure. Measurements in mm.

Valve	L	A	H	W	B	H/L	A/L	W/L	B/L	N	Depository
Right	14.8	7.7	13.1	3.6	3.0	0.89	0.52	0.24	0.20	13	MIMB
Left	14.4	7.3	12.8	3.3	—	0.89	0.51	0.23	0.21	13	2/35176
Right	15.7	8.8	14.9	3.7	3.6	0.95	0.56	0.24	0.23	16	MIMB
Left	15.5	8.5	14.3	3.5	—	0.92	0.55	0.23	0.23	16	2/35176
Right	*20.3*	*11.2*	*18.0*	*4.6*	*4.5*	*0.89*	*0.55*	*0.23*	*0.22*	*15*	MIMB
Left	*20.0*	*10.9*	*17.1*	*4.3*	—	*0.86*	*0.55*	*0.22*	*0.23*	*15*	1/35175

ovately quadrangular, thick, strong, white under periostracum, slightly inequivalve; right valve slightly higher, longer, slightly more inflated; periostacum fairly thick, adherent, brown, extending into inner shell surface, in dry shells easily peeling off ventral margin; surface with conspicuous growth lines, without pustules; beaks slightly posterior to mid-line, somewhat rounded, opisthogyrate; anterior end rounded; posterior end decidedly truncate, with a faint radial ridge extending from posterior portion of beaks to transition of posterior shell margin to ventral margin; anterodorsal margin slightly convex, steeply extending ventrally, sometimes forming a very smooth angle at transition to anterior margin; anterior margin slightly curved, smoothly transitioning to ventral margin; ventral margin slightly curved; posterodorsal margin slightly concave, steeply extending ventrally, abruptly transitioning to posterior margin, forming a distinct angle; posterior margin straight, vertically extending ventrally, forming a smooth angle at transition to ventral margin; lunule present only in left valve, wide, deep, well expressed along entire anterodorsal margin, demarcated by a ridge extending along anterodorsal margin from beaks to anterior margin; escutcheon wide, deep, more expressed in left valve, demarcated by ridges, extending along posterodorsal margin from beaks to dorsal margin.

Interior. Right valve anterior to beak with a conspicuous small toothlike process on inner part of anterodorsal margin, not covered with periostracum; in left valve anterior to beak, inner part of anterodorsal margin slightly concave; elongate-trigonal subumbonal structure for lithodesma attached to shell wall rather short; pillars supporting this structure long, rather massive, becoming thinner ventrally; width of pillars approximately equal to width of pits between them; number of pillars varies from 13 to 16; lithodesma butterfly-shaped; anterior adductor muscle scar large, elongate; posterior adductor scar large, rounded; pallial sinus short, broad, of same shape in both valves, not reaching middle of shell, stopping just short of midline; ventral edge of pallial sinus not confluent with pallial line.

Variability: Variability in the proportions of the shell was observed. The shell of one specimen was distinctly higher compared to other specimens (Table 3; MIMB 2/35177). The shape of the shell also varies. In young specimens, the beaks are more prominent, the anterodorsal margin straighter, the anterior end of the shell is more angular because smoothed angles are formed in the transition of the anterodorsal margin to the anterior margin and the anterior margin to the ventral margin. In the largest specimen, the anterior end of the shell is rounded, the anterodorsal margin is slightly convex, and the shape of the shell is close to oval. The number of pillars in the subumbonal structure varies and probably is not greatly de-

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Explanation of Figures 24–38.

Lampeia posteroresecta Kamenev, sp. nov. Figures 24–29. Holotype, (MIMB 1/35175), Rok Bay, Iturup Island, Kurile Islands (44°11′N, 147°28′6″E), 180 m depth. Figures 24, 25. Left valve, length 20.0 mm. Figures 26, 27. Right valve, length 20.3 mm. Figure 28. Dorsal view of both valves. Figure 29. Ventral view of lithodesma. Scale = 1 mm. Figures 30–35. Paratype (MIMB 2/35176), Fourth Kurile Strait, Kurile Islands (49°38′5″N, 155°22′3″E), 500 m depth. Figures 30, 31. Left valve of a young specimen, length 14.4 mm. Figures 32, 33. Right valve of a young specimen, length 14.8 mm. Figure 34. Dorsal view of both valves of a young specimen. Figure 35. Ventral view of lithodesma. Scale = 1 mm. Figures 36–38. Paratype (MIMB 2/35176), Fourth Kurile Strait, Kurile Islands (49°38′5″N, 155°22′3″E), 500 m depth. Close-up of a right valve showing the buttressed subumbonal structure with ligament and the tooth-like process on the anterodorsal margin. Scale = 1 mm. Figure 36. Interior view. Figure 37. Anteroventral view. Figure 38. Dorsal view of toothlike process.

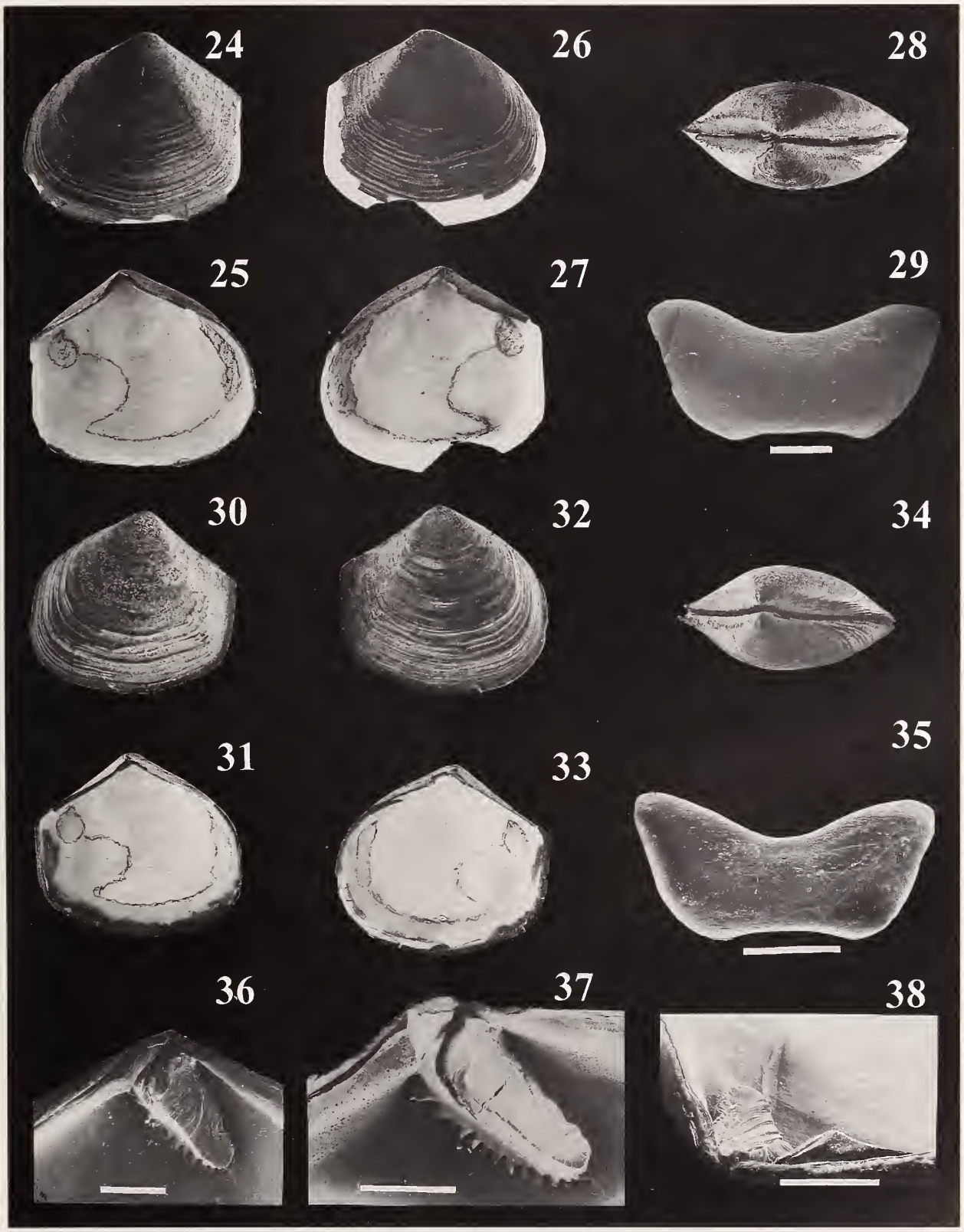
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Table 4

Lampeia adamsi (MacGinitie, 1959). Shell parameters of the holotype (in italics) (MacGinitie, 1959) and specimens from the Sea of Okhotsk (MIMB 1/35177; 2/35178) and the northwestern part of the Bering Sea (UAM 4473): L—shell length; A—anterior end length; H—height; W—width; B—lithodesma length; H/L—height–length ratio; A/L—anterior end length–length ratio; W/L—width–length ratio; B/L—lithodesma length–length ratio; N—number of pillars in the buttressed subumbonal structure. Measurements in mm.

Valve	L	A	H	W	B	H/L	A/L	W/L	B/L	N	Depository
Right	12.6	7.9	10.0	2.5	—	0.80	0.63	0.20	—	13	UAM
Left	—	—	—	—	—	—	—	—	—	—	4473
Right	13.6	8.0	10.4	2.8	—	0.76	0.60	0.20	—	10	UAM
Left	—	—	—	—	—	—	—	—	—	—	4473
Right	15.7	10.3	12.5	3.3	—	0.80	0.66	0.21	—	17	UAM
Left	15.4	10.0	12.1	2.9	—	0.79	0.65	0.19	—	17	4473
Right	16.6	9.2	13.8	3.8	3.7	0.83	0.55	0.23	0.22	15	MIMB
Left	16.3	9.0	13.6	3.0	—	0.83	0.55	0.18	0.23	15	1/35177
Right	*22.8*	—	*18.3*	*6.1*	—	*0.80*	—	*0.26*	—	*15*	USNM
Left	*22.8*	—	*17.3*	*4.4*	—	*0.76*	—	*0.19*	—	*15*	610301
Right	29.7	17.5	25.8	7.7	7.0	0.87	0.59	0.26	0.24	21	UAM
Left	29.1	17.0	24.0	4.9	—	0.82	0.58	0.17	0.24	21	4473
Right	26.7	15.4	21.5	7.1	7.0	0.81	0.58	0.27	0.26	16	MIMB
Left	25.2	14.3	19.8	4.5	—	0.79	0.57	0.18	0.28	16	2/35178

termined by shell size. Some pillars are not attached to the shell wall or are ventrally bifurcated. Lithodesma shape varies but always resembles a butterfly. The lithodesma in larger specimens is longer compared to the shell length.

Type material and locality: Holotype (MIMB 1/35175), Rok Bay, Iturup Island, Kurile Islands (44°11′0″N, 147°28′6″E) (Figure 1), 180 m depth, sand and silt, Coll. V. I. Lukin, 31 July 1987 (R/V *Tikhookeansky*). Paratypes (2) (MIMB 2/35176), the Fourth Kurile Strait, Kurile Islands (49°38′5″N, 155°22′3″E), 500 m depth, sandy silt, Coll. V.I. Lukin and S. I. Grebelny, 27 October 1987 (R/V *Tikhookeansky*).

Distribution and habitat (Figure 1): Known only from type locality.

Comparison: In contrast to other species of the genus, the posterior margin of *L. **posteroresecta*** is vertically directed downward. This species also distinctly differs from *L. adamsi* by having a toothlike process on the inner margin of the anterodorsal margin in the right valve. As compared to the most externally similar species, *L. **triangula,*** *L. **posteroresecta*** also has smaller, somewhat rounded beaks, opisthogyrate, less sharply sloping anterodorsal and posterodorsal shell margins, larger apical angle, shell shape closer to ovately quadrangular than to trigonal, thinner pillars supporting subumbonal structure for lithodesma, more conspicuous toothlike process of the anterodorsal margin of the right valve.

Etymology: Posteriorly truncate (Latin).

Lampeia adamsi (MacGinitie, 1959)

(Figures 39–59, Table 4)

Thracia (Lampeia) adamsi MacGinitie, 1959:163–164, pl. 18, fig. 9; pl. 21, figs. 7, 8; pl. 24, fig. 8; Keen, 1969: 850–851, fig. F27, 8a–d.

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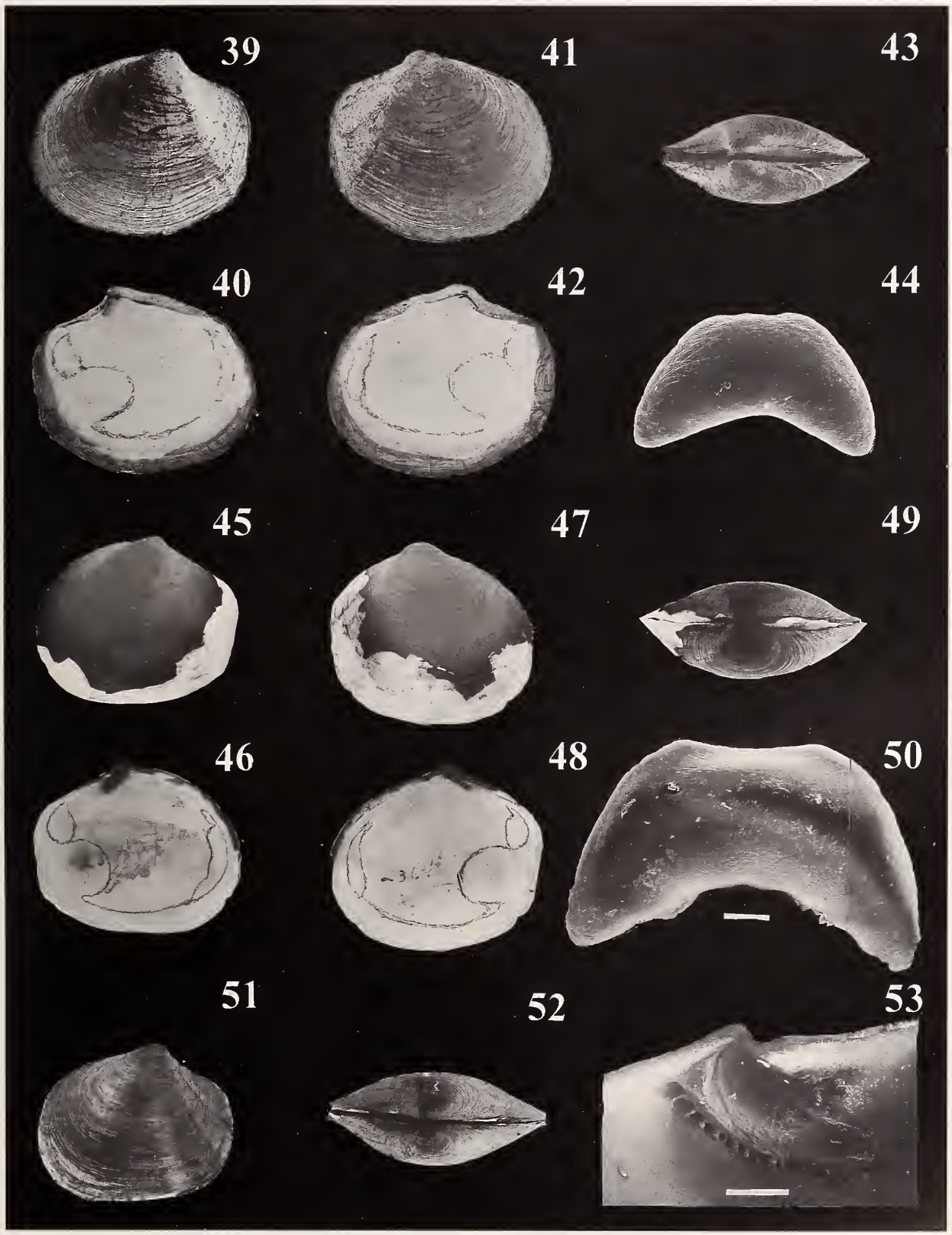
Explanation of Figures 39–53.

Lampeia adamsi (MacGinitie, 1959). Figures 39–44. Young specimen (MIMB 1/35177), Sakhalinsky Bay, Sea of Okhotsk (54°27′2″N, 141°50′8″E), 65 m depth. Figures 39, 40. Left valve, length 16.3 mm. Figures 41, 42. Right valve, length 16.6 mm. Figure 43. Dorsal view of both valves. Figure 44. Ventral view of lithodesma. Scale = 1 mm. Figures 45–53. Adult and young specimens (UAM 4473), Mys Chaplino, Chukotskiy Poluostrov, NW Bering Sea (64°18′50″N, 171°8′W), depth 41 m. Figures 45, 46. Left valve of an adult specimen, length 29.1 mm. Figures 47, 48. Right valve of an adult specimen, length 29.7 mm. Figure 49. Dorsal view of both valves of an adult specimen. Figure 50. Ventral view of lithodesma of an adult specimen. Scale = 1 mm. Figure 51. Left valve of a young specimen, length 15.4 mm. Figure 52. Dorsal view of both valves of a young specimen. Figure 53. Close-up of a right valve of a young specimen showing the buttressed subumbonal structure without ligament and the inner part of the dorsal margin near beak. Scale = 1 mm.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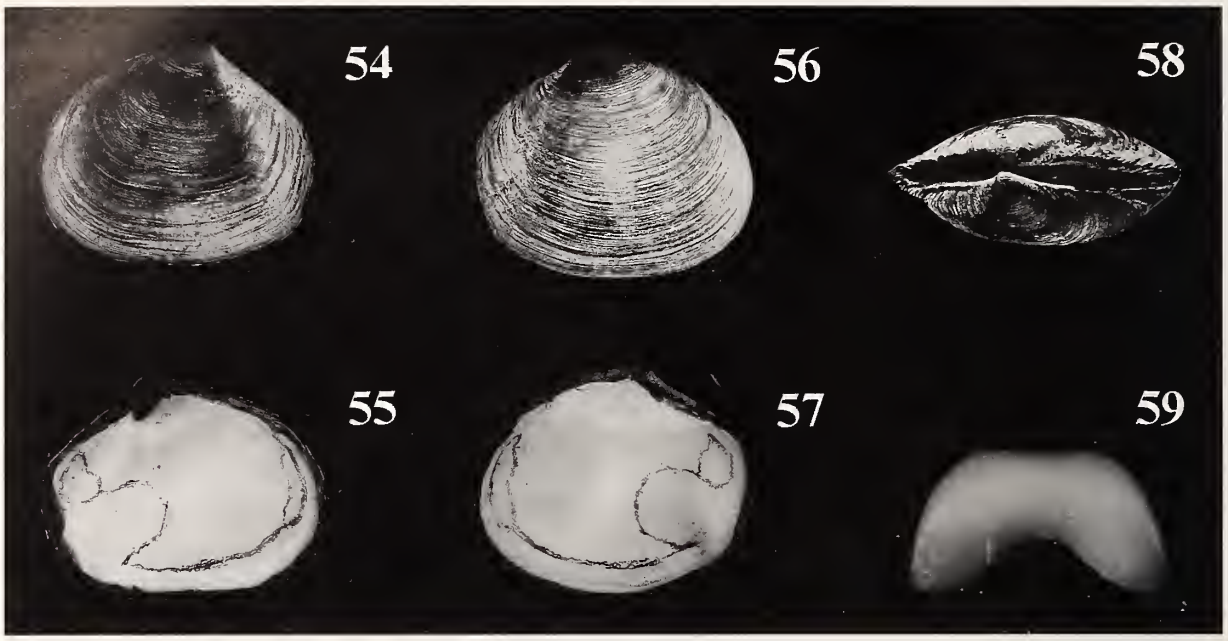

Explanation of Figures 54–59

Lampeia adamsi (MacGinitie, 1959). Adult specimen (MIMB 2/35178), west coast of Kamchatka, Sea of Okhotsk (54°N, 155°06′E), 85 m depth. Figures 54, 55. Left valve, length 25.2 mm. Figures 56, 57. Right valve, length 26.7 mm. Figure 58. Dorsal view of both valves. Figure 59. Ventral view of lithodesma, length 7 mm.

Lampeia adamsi (MacGinitie, 1959), Baxter, 1987:32; Coan, 1990:43–45, figs. 43, 43a, 44; Foster, 1991:133; Feder et al., 1994a:161.

Diagnosis: Shell ovately subquadrate; beaks slightly posterior to midlines, rounded, opisthogyrate; anterior end obtusely rounded; posterior end broadly subtruncate; anterodorsal margin convex; posterodorsal margin straight; posterior margin anteriorly directed; toothlike process on inner part of anterodorsal margin absent in right valve; pillars supporting subumbonal structure for lithodesma short and thin, separated from anterodorsal shell margin by a large, deep pit; lithodesma simple, very curved.

Description (expanded from that of MacGinitie, 1959, and Coan, 1990): *Exterior.* Shell small (to 29.7 mm, UAM 4473, NW Bering Sea), ovately subquadrate, thick, strong, white under periostracum, inequivalve, right valve higher, longer, much more inflated than left valve; periostracum fairly thick, adherent, brown, extending into inner shell surface, in dry shells easily peeling off along ventral margin; surface with conspicuous growth lines, without pustules; beaks rounded, opisthogyrate, slightly posterior to midline; anterior end obtusely rounded; posterior end broadly subtruncate, with a faint radial ridge extending from posterior portion of beaks to transition of posterior margin to ventral margin, with a few microscopic spines along lower two-thirds and a suggestion of a second row of spines midway of area posterior to ridge; anterodorsal margin convex, rather steeply extending ventrally, smoothly transitioning to a rounded anterior margin; ventral margin slightly curved in right valve, straight in left valve; posterodorsal margin straight, rather steeply extending ventrally, forming a smooth angle at transition to posterior margin; posterior margin straight, anteriorly directed, forming a very smooth angle at transition to ventral margin; lunule present only in left valve, wide, deep, well expressed along entire posterodorsal margin, demarcated by a ridge extending along anterodorsal margin from beaks to anterior margin; escutcheon wide, deep, more expressed in left valve, demarcated by ridges, extending along posterodorsal margin from beaks to dorsal margin.

Interior. Toothlike process on inner part of anterodorsal margin absent in right valve; elongate-trigonal subumbonal structure for lithodesma rather elongate; pillars thin, short, becoming thinner ventrally, their width equal to or less than the pits between them, separated from anterodorsal shell margin by a large, deep pit; number of pillars varies from 10 to 21; lithodesma large, very curved; interior of shell chalky; anterior adductor muscle large, elongate; posterior adductor scar large, rounded; pallial sinus short, broadly U-shaped in left valve, rounded, somewhat larger in right valve, stopping just short of midline; ventral edge of pallial sinus not confluent with pallial line.

Variability: Shell shape and proportions distinctly change with age (Table 4). In young specimens, in con-

trast to adults, the shell is much thinner, much more elongate, the shape closer to quadrangular; valves are less inflated; beaks sharper and placed more posteriorly; periostracum is lighter in color, yellowish-brown; in the posterior part of the shell the second row of spines can be more conspicuous or absent; anterodorsal margin straight and from the beaks extending almost horizontally, parallel to ventral margin; posterodorsal margin very smoothly extending ventrally; posterior margin slightly curved, almost vertically extending ventrally only slightly turned anteriorly; lunule in left valve absent; escutcheon shorter, narrower, much more weakly expressed. The number of the pillars varies and probably increases with shell size; some of the pillars may not be attached to shell wall.

Type material and locality: Holotype (USNM 610301), 4 km off Point Barrow, Arctic coast of Alaska (about 71°31′N, 156°23′W), 33.5 m depth, mud-gravel-stone bottom, Coll. G.E. MacGinitie, 15 September 1948 (MacGinitie, 1959; Coan, 1990).

Material examined: 1 lot (UAM 4473) from NW Bering Sea, Mys Chaplino, Chukotskiy Poluostrov (64°18′50″N, 171°8′W) (Coan (1990) made a minor mistake, giving the coordinates 64°18′30″N), depth 41 m, Coll. S. Stoker, 28 July 1973 (2 specimens and 2 right valves); 1 lot (MIMB 2/35177) from west coast of Kamchatka, Sea of Okhotsk (54°N, 155°06′E) (Figure 1), 85 m depth, sand + gravel + silt, bottom temperature +0.4°C, Coll. V.A. Nadtochy, 21 July 1996 (R/V *Professor Levanidov*) (1 specimen); 1 lot (MIMB 1/35177) from Sakhalinsky Bay, Sea of Okhotsk (54°27′2″N, 141°50′8″E), 65 m depth, large-particle sand, bottom temperature +1.5°C, Coll. V.N. Koblikov, 30 July 1977 (R/V *8-452*) (1 specimen).

Distribution and habitat: On the Arctic coast of Alaska, from off Point Barrow (71°34′N, 156°22′W) westward into the NW Bering Sea off Mys Chaplino, Chukotskiy Poluostrov (64°18′50″N, 171°8′W) (UAM 4473), 10–41 m (Coan, 1990); west coast coast of Kamchatka, Sea of Okhotsk (54°N, 155°06′E); Sakhalinsky Bay, Sea of Okhotsk (54°27′2″N, 141°50′8″E). In the Chukchi Sea on the Arctic coast of Alaska, between Point Barrow and Icy Cape (depth 23–30 m) this species was recorded on sand (97.6%) and sand (82.9–84.2%) + mud + silt at a bottom water temperature of 1–2°C (Feder et al., 1994a, b; H. M. Feder, personal communication). Off Point Barrow this species (type specimen) was recorded on mud-gravel-stone bottom (MacGinitie, 1959). In the Sea of Okhotsk (depth 65–85 m), this species was recorded on sand and sand + gravel + silt at a bottom water temperature of 0.4–1.5°C.

Comparison: This species is easily distinguished from *L. **triangula*** and *L. **posteroresecta*** by its ovately-subquadrate shell, lack of a toothlike process on the anterodorsal margin of the right valve, presence of a large, deep pit separating pillars of the subumbonial structure from the anterodorsal shell margin, and its simple, curved lithodesma.

DISCUSSION

Distribution

The species of *Lampeia* are clearly rare and occur only in small areas of the northwestern Pacific and Arctic. The eastern border of the habitat of the most studied species, *L. adamsi,* in the Arctic is Point Barrow, at the boundary between the Chukchi and Beaufort seas (156°) (Ushakov, 1952). This species was not found in the western part of the Beaufort Sea (Bernard, 1979). It is recorded only in the western part of the Chukchi Sea, where it is very rare. Thus, as a result of a detailed study of the composition and distribution of macrobenthos in the northeastern Chukchi Sea, *L. adamsi* was found only in a small area between Point Barrow and Icy Cape at three stations (CH 6, CH 17, CH 19) in seven samples (11 specimens) (Feder et al., 1994a, b; H.M. Feder, personal communication). In the northwestern part of the Bering Sea, this species was found also in the local area in two samples (UAM 4473 and 64°23′N, 169°31′W, 39.8 m) (N. R. Foster, personal communication). In the Sea of Okhotsk, we found it only in two samples. This species is thus very rarely represented in collections. Coan (1990), when studying the available material of thraciids in museum and private collections, found *L. adamsi* only in eight lots, including the type. The same thing can be said about the distribution of other species of this genus.

We have studied the materials of 15 expeditions of different institutes of Russia, which collected the samples of macrobenthos in the shelf zone of the western part of the Bering Sea and the southeastern Kamchatka from Bering Strait to Lopatka Cape (Kamchatka), the Commander Islands, all the Sea of Okhotsk and also the shelf and bathyal zones of all the Kurile Islands. In total, 1930 benthos stations were examined (4409 samples). *Lampeia* was found only at 10 stations. It is interesting that at the coastal zone of the western Kamchatka three PRIFO expeditions worked (R/V *Ekvator,* 1982; R/V *Dalny,* 1989; R/V *Professor Levanidov,* 1996), and collected benthos samples using a standard technique at the same stations. However, *L. **triangula*** was found in that region only in 1989 and *L. adamsi* only in 1996.

Lampeia, as compared with most representatives of the family Thraciidae, has a thick shell, which is very rarely damaged during the collection and treatment of benthos samples. Thus, the fact that only a few individual specimens were found in different parts of the northwestern Pacific Ocean and the Chukchi Sea is probably due only to their local distribution within their habitat area where they occur only at a low density. Thus, the average density of *L. adamsi* in the northeastern part of the Chukchi Sea at three stations varied from 6–8 ind/m^2 (H. M. Feder, personal communication) and in the Sea of Okhotsk was

4 ind/m^2. The population density of *L. **triangula*** near the western coast of Kamchatka, according to the results of two quantitative samples, was 4 and 8 ind/m^2. The population density of *L. **posteroresecta*** in the Fourth Kurile Strait was 8 ind/m^2.

Of the three species, *L. adamsi* is the more shallow-water species. In all parts of the species range, this species occurs at relatively shallow depths (10–85 m), mainly on sand or sand with a slight admixture of silt. The other two species were found at significantly greater depths (*L. **triangula,*** 144–214 m, *L. **posteroresecta,*** 180–500 m) and only on silty sand or sandy silt. Probably, the great differences in habitats account for the marked morphological differences between *L. adamsi* and the more closely related *L. **triangula*** and *L. **posteroresecta.***

Inner Shell Morphology

It is known that representatives of the family Thraciidae have a edentulous hinge. Only the juveniles of *Thracia curta* have an anterior lateral tooth in the right valve, and it disappears with growth (Coan, 1990). As we already mentioned, *L. **triangula*** and *L. **posteroresecta*** have a conspicuous toothlike process on the anterodorsal shell margin of the right valve; it is very similar in its shape and structure to a true lateral tooth. However, despite this similarity, it cannot be considered a true tooth for a number of reasons. In the left valve of both species, there is no tooth or cavity on the inner part of the dorsal margin that would correspond to this process. The inner part of the dorsal margin in the left valve is straight and smooth, and is only slightly concave just anterior to the beak to match the toothlike process in the right valve when the valves are closed. In almost all the *L. **triangula*** studied, with the exception of a few juvenile specimens, the toothlike process is completely covered with periostracum. It is evident that it does not extend into the inner part of the shell. The lower part of this process fits into a small depression in the lithodesma and probably provides a better attachment of the lithodesma to the shell. Because of the small depression for the toothlike process on one side, the lithodesma, despite its variability, has a butterflylike shape only in *L. **triangula*** and *L. **posteroresecta.***

In the studied specimens of *L. **posteroresecta,*** the toothlike process is more conspicuous and is not covered with periostracum. However, it may also be covered with periostracum, which was damaged and fell away in the process of opening the shell. In all the specimens of this species, in the area of the toothlike process, we found fresh fractures on the periostracum. Probably, the periostracum broke away because, in contrast to *L. **triangula,*** the material of this species was stored dry and the periostracum became more fragile.

The subumbonal structure for the lithodesma of *Lampeia* is also of considerable interest. As Coan (1990) said, the buttressed subumbonal structure is unique. MacGinitie (1959), in describing *L. adamsi,* gave an exact number of the pillars supporting this structure. Our studies of the two new species, show that the exact number of the pillars is very difficult to determine because some of them either bifurcate ventrally or are not connected to the shell wall and look like stalactites. Moreover, the number of pillars within each of the species can vary rather greatly. Thus, the number of pillars is probably not a reliable character in identifying species of *Lampeia.* In this case, we can only say that some species have more pillars than others. On the other hand, the shape of the pillars does not vary much within a species, and this characteristic may be much more species-specific.

In general, the number of the pillars was equal in both valves. However, because it is sometimes very difficult to count the number of pillars, we may have made errors in calculations. Thus, in the future, when more studies will be made using additional material, it is possible that the number of pillars in different valves of some specimens will be found to differ.

Note Added in Proof: While the present paper was in press, Mr. A Yu. Voronkov (Zoological Institute, St. Petersburg) informed us about the first record of *Lampeia adamsi* from the western Chukchi Sea (68°38′1″N, 177°58′8″E), 33 m depth, sandy site, coll. B. J. Sirenko, 27 August 1989 (R/V *Dmitry Laptev*).

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